Part of the difficulty of Physics comes from the lack of fluency most people have with the language of Physics. So let's review some definitions.

Speed: The rate at which you move (*units*: meters/second or m/s)
Velocity: The rate at which you move including the direction (e.g. - 5 m/s north)
Acceleration: The rate at which your velocity is changing (*units*: m/s/s or m/s^2)

Given the definitions provided here, try to answer the following questions.

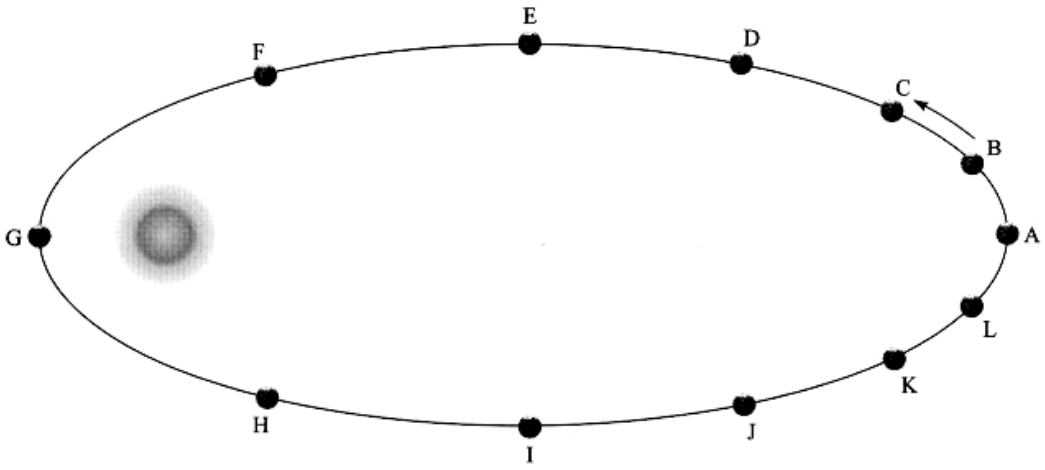
1. If you are driving down a straight street at a speed of 30 miles per hour. You come to a stop sign and being the law-abiding driver that you are, you hit the brakes and come to a stop, all while moving in a straight line. Were you moving with a constant velocity? Did you accelerate? *Briefly explain your reasoning.*

2. You are driving northwest on a highway at 65 miles per hour. The highway banks such that you are now driving due west. If you drove at a constant speed of 65 miles per hour, did you move with constant velocity? Did you accelerate? *Briefly explain your reasoning.*

3. Consider the following debate between two students about their answer to the previous question.

   Student 1: *I thought that if the driver is moving at a constant 65 miles per hour, the are not changing the rate at which they are moving. Since acceleration is supposed to be the change in velocity, there is no acceleration.*
   Student 2: *I disagree with you. Acceleration is supposed to be how fast velocity is changing, and velocity is not only how fast you are moving, but also the direction. Since you changed the direction you were moving, you changed your velocity. Since you changed your velocity, you had to have accelerated!*

   Do you agree or disagree with either or both of the students? *Explain your reasoning.*



This orbital diagram is an adaptation of a figure from the "Kepler's Second Law" lecture tutorial, from ***Lecture Tutorials in Astronomy****, 2nd Ed., by E. Prather, et al., Pearson Addison-Wesley (2007).*

Above is the diagram of the orbit of a hypothetical comet orbiting the Sun. The dots are placed at one month intervals.

4. Based on what you have learned about Kepler's 2nd Law, rank the following positions in order of the comet's speed from slowest to fastest: A, E, G, I.

   FASTEST SLOWEST

5. Draw an arrow in the direction the comet is moving at position A. Do the same for positions E, G, and I. Make the length of the arrow related to its speed (longer arrows mean it is moving fastest.

6. Is this comet accelerating? *Explain your reasoning.*

7. If the comet was in a perfectly circular orbit around the Sun, would its speed be changing? *Explain your reasoning.*

8. If the comet was in a perfectly circular orbit around the Sun, would it be accelerating? *Explain your reasoning.*

One of Galileo's contributions to science was his writings about his observation that:

All objects, regardless of their weight, fall at the same rate as long as air resistance is not important.

Before this writing, Aristotle's theory describing objects falling near the Earth's surface was assumed to be correct. That theory can be paraphrased as

Those objects made mostly of water and Earth fall toward their natural position in the universe. Since the Earth is the center of the Universe, it makes sense that those objects would fall toward the center of the Universe. Furthermore, the speed at which the object falls towards its natural location depends on the weight of that object.

9. Suppose Galileo actually conducted the experiment he wrote about at the Tower of Pisa. Suppose he simultaneously dropped two weights, one with a weight of 10 pounds and the other with a weight of 1 pound, from the top of the tower. What would Aristotle predict for a result?

10. Given Galileo's statement, what do you think he would have predicted?

In reality, we are not certain Galileo did an experiment at the Tower of Pisa. However, we are certain he was able to reason out that Aristotle's view of gravity certainly didn't make sense. Consider the following…

11. Imagine you have three one pound weights and you simultaneously drop them from the tower side by side. If you are Aristotle, what do you predict as a result?

12. Suppose now you tie two of the weights together with an incredibly light thread, so that you have a one pound weight and a two pound weight. Should this new 'two pound weight' fall faster?

13. What if as the new 'two pound weight' is falling the thread snaps, should the weights slow down? *Explain your reasoning assuming Aristotle is correct… can you?*